The program has been developed to provide students with a broad base in the engineering profession or for advanced study at the graduate level. The department offers Bachelor of Science degrees in Mechanical Engineering, Industrial Engineering, and Engineering Management. All programs are offered in an economically thriving, industrialized, and world-class city. The campus is located in the heart of Chicago, and has a diverse student body in a leading-edge research environment.

Accreditation

The Department of Mechanical and Industrial Engineering offers two programs accredited by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology. These degrees are the Bachelor of Science in Mechanical Engineering and Bachelor of Science in Industrial Engineering.

Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology
415 North Charles Street
Baltimore, Maryland 21201
(410) 347-7700

BS in Industrial Engineering

Industrial engineering is concerned with the design, improvement, and installation of integrated systems of people, material, and equipment. The Industrial Engineering program gives knowledge of principles and methods in engineering design, physical sciences, and social sciences. This knowledge then is used to specify, predict, and evaluate systems. By collecting, analyzing, and arranging such knowledge, industrial engineers enable management to utilize resources effectively and efficiently.

In order to design and operate complex systems, the industrial engineer must acquire comprehensive knowledge in the following areas: manufacturing engineering; production engineering; systems engineering; and human factors, maintenance, and safety engineering. Manufacturing engineering is involved with planning and selecting manufacturing methods, with designing and developing manufacturing equipment, and with increasing the efficiency and productivity of current manufacturing technologies as well as creating new ones. Manufacturing engineers use materials science, metal cutting and forming theories, stochastic-dynamic models, principles of numerical and adaptive control, engineering statistics, and other physical sciences to solve manufacturing problems. A new area in manufacturing is virtual manufacturing, which combines virtual reality techniques, factory design, equipment design, training, and contamination control in industrial applications.

Production engineering deals with the analysis, design, installation, and maintenance of operational and management systems involved in the production and distribution of goods and services. Such topics as quality control, production scheduling, production planning, inventory control, and maintenance policy are included in this area.

Systems engineering involves the theory and practice of modeling a general system design. The systems engineer develops mathematical, statistical, and computer models of complex systems to predict how a design or policy change will affect the real world. Human factors, maintenance, and safety engineering deal with the problems caused by the interaction of complex man-machine systems. The engineers in this area apply knowledge about sensory, perceptual, and mental characteristics in the engineering design of equipment and facilities to ensure worker comfort and safety.

Because the training of industrial engineers is so broad, they are in demand not only in all types of industry but also in service organizations, such as hospitals, banks, insurance companies, and research laboratories.

The program also emphasizes computer applications, professional ethics, communication skills, ability to work in a multidisciplinary team and awareness of broad education, lifelong learning, and contemporary issues.
The objectives of the Bachelor of Science in Industrial Engineering can be found online.

**BS in Engineering Management**

The College of Engineering and the College of Business Administration offer a joint program in engineering management that allows students latitude to study in both the business administration and engineering disciplines. This program prepares students to begin careers that may lead to administrative, staff, or management positions in small technological engineering or manufacturing operations or positions as production supervisors, administration staff, or managers of departments in large technological organizations. The program also prepares students for careers in large nontechnological organizations such as banks, which may require a combination of engineering and management experiences.

The Bachelor of Science in Engineering Management is awarded by the College of Engineering. Entrance requirements are the same as for the College of Engineering.

To complete the required 128 semester hours of university credit, students take required courses in engineering as well as courses in business administration, including accounting, finance, marketing, economics, and management. Additionally, there are required courses in English composition, mathematics, chemistry, and physics. Engineering courses are chosen from courses acceptable for other students in the College of Engineering. No more than 32 hours may be taken in courses offered by the College of Business Administration.

**Accreditation**

- The industrial engineering program at UIC is accredited by the Engineering Accreditation Commission of ABET.
- The mechanical engineering program at UIC is accredited by the Engineering Accreditation Commission of ABET.

**Degree Programs**

- BS in Mechanical Engineering
- BS in Industrial Engineering
- BS in Engineering Management

**Minors**

- Minor in Mechanical Engineering
- Minor in Industrial Engineering

**Industrial Engineering**

**IE 118. Energy for Sustainable Society. 3 hours.**
Focuses on how energy systems work today and how they can work in a decarbonized sustainable future, while still meeting the critical energy needs of global developed and developing societies. Course Information: Same as ME 118. Individual and Society course.

**IE 198. Special Topics in Engineering Graphics. 1-4 hours.**
Specific topics are announced each term. Course Information: May be repeated. Students may register in more than one section per term. Prerequisite(s): Prerequisite may vary by section according to topic.

**IE 201. Financial Engineering. 3 hours.**
Principles and techniques of economic analysis in engineering; Financial decision making; Single and multi project selection techniques. Course Information: Prerequisite(s): MATH 181.

**IE 312. Dynamic Systems and Control. 3 hours.**
Dynamics of linear systems. Modeling of mechanical, electrical, fluid, and thermal systems. Analysis and design of feedback control systems. Analytical, computer and experimental solution methods. Time and frequency domain techniques. Course Information: Same as ME 312. Prerequisite(s): CS 109 and ECE 210 and MATH 220; and sophomore standing or above; or approval of the department.

**IE 342. Probability and Statistics for Engineers. 3 hours.**
Probability, random variables, mathematical expectation, discrete and continuous distributions, sampling distributions, estimation theory, and test of hypothesis. Course Information: Prerequisite(s): MATH 181.

**IE 345. Regression Applications and Forecasting in Engineering. 3 hours.**
Single and multiple regression analysis of variance, examination of residuals, introduction to time series analysis, and analytical forecasting techniques; application to engineering system. Course Information: Prerequisite(s): IE 342.

**IE 365. Work Productivity Analysis. 4 hours.**
Operations analysis; man-machine relationship; motion study; micromotion study, time study; predetermined time systems; performance rating; standard data techniques; work sampling; wage payment plans. Course Information: Prerequisite(s): IE 342. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

**IE 380. Manufacturing Process Principles. 3 hours.**
Introduction to basic manufacturing processes such as casting, bulk deformation, sheet metal forming, metal cutting. Interaction between materials, design and manufacturing method. Economics of manufacturing. Course Information: Same as ME 380. Prerequisite(s): CME 203.

**IE 391. Industrial Engineering Practicum. 1 hour.**
Provides students with the opportunity to apply the skills and knowledge gained in previous engineering courses within a professional, working environment. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 1 hour awarded toward degree requirements. Prerequisite(s): Approval of the Department.

**IE 392. Undergraduate Research. 1-3 hours.**
Research under close supervision of a faculty member. Course Information: May be repeated to a maximum of 6 hours. Prerequisite(s): Consent of the head of the department.

**IE 394. Senior Capstone Design. 4 hours.**
Systematic approach to the design process. Creative problem solving. Design methodology and engineering principles applied to open-ended design problems with inherent breadth and innovation. Course Information: Same as ME 394. Credit is not given for IE 394 if the student has credit for ME 396 or IE 396. Prerequisite(s): Senior standing or above; or approval of the department.
IE 396. Senior Design I. 0-3 hours.
Systematic approach to the design process. Creative problem solving. Design methodology and engineering principles applied to open-ended design problems with inherent breadth and innovation. Course Information: Same as ME 396. Credit is not given for IE 396 if the student has credit in IE 444 or ME 444 or IE 445 or ME 445. Prerequisite(s): ME 347; or IE 345. Open only to seniors. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

IE 397. Senior Design II. 2 hours.
The systematic approach to the design process; creative problem solving; design methodology and engineering principles learned in ME 396 are applied to complete the Senior Design project. Course Information: Same as ME 397. Credit is not given for IE 397 if the student has credit for IE 444 or ME 444 or IE 445 or ME 445. Prerequisite(s): ME 396; or IE 396; and senior standing or above; or consent of the instructor. Requires concurrent registration in ME 499 or IE 499.

IE 411. Mechatronics I. 0-4 hours.
Elements of mechatronic systems, sensors, actuators, microcontrollers, modeling, hardware in the loop simulations, real time software, Electromechanical systems laboratory experiments. Course Information: Same as ME 411. 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Senior standing or above or approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

IE 412. Dynamic Systems Analysis I. 3 or 4 hours.
Classical control theory, concept of feedback, laplace transform, transfer functions, control system characteristics, root locus, frequency response, compensator design. Course Information: Same as ME 412. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 308.

IE 441. Ergonomics and Human Factors. 3 or 4 hours.
The study of principles and techniques associated with ergonomic problems. Topics include human information input and processing, human output and control, and ergonomic considerations in safety. Course Information: Same as EOHS 441. Previously listed as IE 341. 3 undergraduate hours; 4 graduate hours. Prerequisite(s): Credit or concurrent registration in IE 342 or consent of the instructor.

IE 442. Design and Analysis of Experiments in Engineering. 0-4 hours.
Covers different methods for statistical design of engineering experiments, executing them and analyzing their results. Course Information: Prerequisite(s): IE 342. Class Schedule Information: To be properly registered, student must enroll in one Lecture-Discussion and one Laboratory-Discussion.

IE 444. Interdisciplinary Product Development I. 3 or 4 hours.
Cross-functional teams (w/students from AD 420/423 and MKTG 594) research and develop new product concepts. Focus on the identification of technologically appropriate product design problems. Course Information: Same as ME 444. 3 undergraduate hours. 4 graduate hours. Year-long (with IE/ME 445) project course. Prerequisite(s): Senior standing or above; and consent of the instructor.

IE 445. Interdisciplinary Product Development II. 4 hours.
Cross-functional teams (w/students from AD 420 and MKTG 594) research and develop new product concepts. Focus on solutions to the opportunities identified in IE/ME 444 to functional prototypes. Serves as a replacement for IE/ME 396. Course Information: Same as ME 445. Year-long (with IE/ME 444) project course. Prerequisite(s): IE 444 or ME 444; and senior standing or above; and consent of the instructor.

IE 446. Quality Control and Reliability. 3 or 4 hours.
Principles of statistical quality control including control by variable and by attribute, construction and use of control charts for variables, fraction defectives and number of defects and use of standard plans, reliability and life cycle testing. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): IE 342.

IE 461. Safety Engineering. 3 or 4 hours.
Human protection systems; accident and emergency handling; manufacturing and service hazard systems. Course Information: Same as EOHS 460. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): IE 342 or consent of the instructor.

IE 463. Plant Layout and Materials Handling. 3 or 4 hours.
Facilities design functions, computer-aided plant layout, facility location, warehouse layout Minimak location, deterministic and probabilistic conveyor models. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Credit or concurrent registration in IE 345 and Credit or concurrent registration in IE 472 and IE 473 and IE 365 and IE 201 and IE 467.

IE 464. Virtual Automation. 0-4 hours.
Fundamentals of manufacturing and automation modeling using CAD/CAM and computer-integrated manufacturing methods; concepts of virtual manufacturing; industrial robots and automated factory models within virtual environments. Course Information: Same as ME 464. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 107 or CS 108. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion, and one Laboratory.

IE 465. Manufacturing Information Systems. 0-4 hours.
Design and implementation of supervisory control and data acquisition systems; manufacturing systems controller and communication networks. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Senior or graduate standing, or consent of the instructor; and familiarity with computer programming. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture-Discussion.

IE 466. Production Planning and Inventory Control. 3 or 4 hours.
Principles of production planning, master scheduling, job sequencing, design and control of deterministic and stochastic inventory systems, material requirement planning. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Credit or concurrent registration in IE 345 and Credit or concurrent registration in IE 472 and IE 473.

IE 467. Discrete Event Computer Simulation Application. 3 or 4 hours.
The solution of industrial application problems by means of discrete event computer simulation. Simulation model building. Input analysis. Output analysis. In depth study of some specific simulation programming languages, with projects. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): IE 342.

IE 468. Virtual Manufacturing. 3 or 4 hours.
Virtual reality applications in manufacturing systems design, manufacturing applications of networked virtual reality, virtual reality modeling of occupational safety engineering. Course Information: Same as ME 468. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 107 or CS 108.
IE 471. Operations Research I. 3 or 4 hours.
Introduction to operations research, formulation of linear programming problems, simplex methods, duality theory, sensitivity analysis, network models, and integer linear programming. Course Information: 3 undergraduate hours. 4 graduate hours. No graduate credit for industrial engineering majors. Prerequisite(s): MATH 310.

IE 472. Operations Research II. 3 or 4 hours.
Nonlinear programming problems, unconstrained optimization search techniques. Kuhn-Tucker theorems, quadratic programming, separable programming, meta heuristics, goal programming, and dynamic programming. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 107 or CS 109, and IE 471 or graduate standing.

IE 473. Stochastic Processes and Queuing Models. 3 or 4 hours.
Stochastic dynamic systems, queuing networks, probabilistic state transition models and nondeterministic decision making models. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): IE 342 and Credit or concurrent registration in IE 471 and MATH 210.

IE 481. Additive Manufacturing Process. 3 or 4 hours.
Covers aspects of additive manufacturing. The types that are covered are generic process, design, vat photopolymerization, extrusion based, jetting, direct writing, 3D bio-printing, powder bed fusion, slicing, and data representation. Course Information: Same as ME 481. 3 undergraduate hours. 4 graduate hours. Recommended background: Manufacturing Processes.

IE 494. Special Topics in Industrial Engineering. 3 or 4 hours.
Particular topics vary from term to term depending on the interests of the students and the specialties of the instructor. Course Information: 3 undergraduate hours. 4 graduate hours. May be repeated. Prerequisite(s): Consent of the instructor.

IE 496. Undergraduate Senior Design Thesis I. 0-8 hours.
Introduction to the principles and practice of product design: specifications, evaluation of design alternatives, technical reports, and oral presentations, through independent design projects. Course Information: Same as ME 496. Credit only given to nondegree students. No graduation credit given to students enrolled in Engineering. Extensive computer use required. Field trips required at a nominal fee. Prerequisite(s): Consent of the instructor.

IE 497. Undergraduate Senior Design Thesis II. 0-8 hours.
Introduction to engineering design and research methods: design tools, product conception and development, simulation, prototyping, technical reports and presentations, literature survey and undergraduate thesis. Course Information: Same as ME 497. Credit only given to nondegree students. No graduation credit given to students enrolled in Engineering. Extensive computer use required. Field trips required at a nominal fee. Prerequisite(s): Consent of the instructor.

IE 499. Professional Development Seminar. 0 hours.
Students are provided general information about their role as UIC MIE alumni in society and the role of the University in their future careers. Students provide evaluations of their educational experience in the MIE department. Course Information: Same as ME 499. Satisfactory/Unsatisfactory grading only. Prerequisite(s): Open only to seniors; and approval of the department. Must be taken in the student's last semester of study.

Mechanical Engineering

ME 118. Energy for Sustainable Society. 3 hours.
Focuses on how energy systems work today and how they can work in a decarbonized sustainable future, while still meeting the critical energy needs of global developed and developing societies. Course Information: Same as IE 118. Individual and Society course.

ME 205. Introduction to Thermodynamics. 3 hours.
Principles of energy transport and work; properties of substances and equations of state; first and second laws of thermodynamics; applications to mechanical cycles and systems. Course Information: Prerequisite(s): PHYS 141 and MATH 181.

ME 210. Engineering Dynamics. 3 hours.
Dynamics of particles and rigid bodies. Introduction to Linear Algebra. Kinematics in different coordinate systems, coordinate transformations. Kinetics: Newton's second law, work energy relations, impulse-momentum relations, impact problems. Course Information: Prerequisite(s): CME 201.

ME 211. Fluid Mechanics I. 4 hours.

ME 250. Introduction to Engineering Design and Graphics. 3 hours.
Engineering design process, modeling, analysis. Product dissection, prototyping. Technical communication. AutoCAD, engineering graphics software, 3-D views, multiview projection, dimensioning and tolerancing, standards. Team design project. Course Information: Prerequisite(s): Eligibility to register for ENGL 160. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

ME 261. Materials for Manufacturing. 2 hours.
Introductory-level course in materials engineering to familiarize students with relationships between processing, structure and properties of materials used to manufacture devices. Course Information: Same as CME 261. Credit is not given for ME 261 if the student has credit for CME 260. Prerequisite(s): CHEM 122 and CHEM 123 and PHYS 141 and MATH 181.

ME 293. Special Problems. 1-4 hours.
Special problems, readings or research under close supervision of a faculty member in the area of engineering graphics. Course Information: May be repeated. Prerequisite(s): Consent of the instructor.

ME 308. Mechanical Vibrations. 3 hours.
Free and forced vibrations of damped linear single and multiple degree of freedom systems. Approximate methods, instrumentation, and applications. Course Information: Same as CME 359. Prerequisite(s): CS 109; and ME 210; and MATH 220.

ME 312. Dynamic Systems and Control. 3 hours.
Dynamics of linear systems. Modeling of mechanical, electrical, fluid, and thermal systems. Analysis and design of feedback control systems. Analytical, computer and experimental solution methods. Time and frequency domain techniques. Course Information: Same as IE 312. Prerequisite(s): CS 109 and ECE 210 and MATH 220; and sophomore standing or above; or approval of the department.
ME 318. Fluid Mechanics II. 3 hours.
Conservation equations for fluid mechanics, inviscid ideal flows, viscous flow solutions of Navier-Stokes equations, pipe flows and boundary flows, compressible flow, computer solutions and applications. Course Information: Prerequisite(s): ME 211.

ME 320. Mechanics and Dynamics of Machinery. 3 or 4 hours.
Kinematic analysis and synthesis of mechanisms; linkages, cams, spur gears, gear trains. Dynamic forces in machines; bearing reactions, balancing, flywheel design, friction, efficiency. Course Information: Prerequisite(s): ME 210.

ME 321. Heat Transfer. 4 hours.
Modes of heat transfer, material properties, one- and two-dimensional conduction. Extended surfaces. Forced and free convection. Heat exchangers. Radiation. Shape factors. Laboratories in conduction, convection, and radiation. Course Information: Prerequisite(s): ME 205 and credit or concurrent enrollment in ME 211. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ME 325. Intermediate Thermodynamics. 3 hours.
In-depth study of thermodynamic principles, thermodynamics of state, vapor and gas power cycles, refrigeration cycles, thermodynamics of nonreacting and reacting mixtures, internal combustion engines, and thermodynamics of equilibrium. Course Information: Prerequisite(s): ME 205 and credit or concurrent registration in ME 211.

ME 341. Experimental Methods in Mechanical Engineering. 3 hours.
Introduction to the theory and practice of experimental methods, measurement techniques, instrumentation, data acquisition and data analysis in mechanical and thermal-fluid systems. Experiments and reports. Course Information: Prerequisite(s): CME 203 and ME 211; and credit or concurrent registration in ME 308. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

ME 347. Introduction to Computer-Aided Design. 3 hours.
Conventional and computer-assisted methods in design. Geometric manipulation. Computer-aided modeling with curves, surfaces, and solids. Design with finite-element analysis. Course Information: Previously listed as ME 447. Extensive computer use required. Prerequisite(s): MATH 220 and CME 203 and ME 250. Recommended background: Credit in MATH 310. Class Schedule Information: To be properly registered, students must enroll in one Laboratory-Discussion and one Lecture.

ME 370. Mechanical Engineering Design. 3 hours.
Mechanical design concepts, failure prevention under static and variable loading, application of engineering mechanics and materials to analysis, selection and design of mechanical elements such as shafts, fasteners, springs, bearings, and gears. Course Information: Prerequisite(s): CME 203, CME/ME 261 or CME 260, and ME 250. Recommended Background: ME 230.

ME 380. Manufacturing Process Principles. 3 hours.
Introduction to basic manufacturing processes such as casting, bulk deformation, sheet metal forming, metal cutting. Interaction between materials, design and manufacturing method. Economics of manufacturing. Course Information: Same as IE 380. Prerequisite(s): CME 203.

ME 391. Mechanical Engineering Practicum. 1 hour.
Provides students with the opportunity to apply the skills and knowledge gained in previous engineering courses within a professional, working environment. Course Information: Satisfactory/Unsatisfactory grading only. May be repeated. A maximum of 1 hour awarded toward degree requirements. Prerequisite(s): Approval of the Department.

ME 392. Undergraduate Research. 1-3 hours.
Research under close supervision of a faculty member. Course Information: May be repeated to a maximum of 6 hours. Prerequisite(s): Consent of the head of the department.

ME 394. Senior Capstone Design. 4 hours.
Systematic approach to the design process. Creative problem solving. Design methodology and engineering principles applied to open-ended design problems with inherent breadth and innovation. Course Information: Same as IE 394. Credit is not given for ME 394 if the student has credit for ME 396 or IE 396. Prerequisite(s): Senior standing or above; or approval of the department.

ME 396. Senior Design I. 0-3 hours.
Systematic approach to the design process. Creative problem solving. Design methodology and engineering principles applied to open-ended design problems with inherent breadth and innovation. Course Information: Same as IE 396. Credit is not given for ME 396 if the student has credit in IE 444 or ME 444 or IE 445 or ME 445. Prerequisite(s): ME 347; or IE 345. Open only to seniors. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ME 397. Senior Design II. 2 hours.
The systematic approach to the design process; creative problem solving; design methodology and engineering principles learned in ME 396 are applied to complete the Senior Design project. Course Information: Same as IE 397. Credit is not given for ME 397 if the student has credit for IE 444 or ME 444 or IE 445 or ME 445. Prerequisite(s): ME 396; or IE 396; and senior standing or above; or consent of the instructor. Requires concurrent registration in ME 499 or IE 499.

ME 401. Applied Stress Analysis I. 3 or 4 hours.
Complex bending and torsion, curved flexural members, energy methods in design, theories of failure. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CME 203.

ME 408. Intermediate Vibration Theory. 3 or 4 hours.
Free and forced vibrations of multi-degree of freedom linear systems. Lagrangian dynamics, matrix, approximate and numerical methods. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 308.

ME 409. Advanced Kinematics I. 3 or 4 hours.
Kinematic synthesis of planar linkages. Higher-order, precision point and approximate synthesis. Unified treatment of position, function, and path-angle problems. Consideration of branching and rotatability. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 320.

ME 410. Automation and Robotics Applications. 3 or 4 hours.
Basic pneumatic and hydraulic systems. Design of sequential control circuits and ladder diagrams. Robot kinematics and dynamics. Robot design. Trajectory planning. Applications and demonstrations. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 210.
ME 411. Mechatronics I. 0-4 hours.
Elements of mechatronic systems, sensors, actuators, microcontrollers, modeling, hardware in the loop simulations, real time software, Electromechanical systems laboratory experiments. Course Information: Same as IE 411. 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Prerequisite(s): Senior standing or above; or approval of the department. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture.

ME 412. Dynamic Systems Analysis I. 3 or 4 hours.
Classical control theory, concept of feedback, laplace transform, transfer functions, control system characteristics. root locus, frequency response, compensator design. Course Information: Same as IE 412. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 308.

ME 413. Dynamics of Mechanical Systems. 3 or 4 hours.
Degrees of freedom, generalized coordinates, principle of virtual work. D'Alembert's Principle, Lagrange's Equation, Hamilton's Principle. Equations of motion and Newton-Euler equations for rigid bodies. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 320.

ME 414. Theory of Gearing and Applications. 3 or 4 hours.
Classification of gear drives. Geometry of plane and spatial gears. Analysis and synthesis of gears with approximate meshing. Applications to spur, helical, worm and bevel gear drives. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 419 or the equivalent.

ME 415. Propulsion Theory. 3 or 4 hours.
Thermodynamics and fluid mechanics of air-breathing engines, performance of rockets; chemical and nuclear rockets. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 415 or the equivalent.

ME 416. Railroad Vehicle Dynamics. 3 or 4 hours.
Introduces analytical and computational methods used for the computer aided dynamic and stability analysis of railroad vehicle systems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 413; or consent of the instructor.

ME 417. Intermediate Fluid Mechanics. 3 or 4 hours.
Development of conservation equations for Newtonian-fluids; continuity, Navier-Stokes and energy equations. Some exact and approximate solutions of highly viscous, viscous and inviscid flows. Boundary layer flows, jets and wakes. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 425.

ME 418. Transport Phenomena in Nanotechnology. 3 or 4 hours.
Free surface flows, rheologically complex liquids, colloidal suspensions, emulsions, Brownian motion, flows in micro- and nanochannels, and multiple applications. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 325 and ME 211.

ME 419. Compressible Flow Theory. 3 or 4 hours.
Conservation laws, one-dimensional flows. Normal and oblique shock waves, Prandtl-Meyer expansion, flow over airfoils. Applications to nozzles, shock-tubes, wind-tunnels. Flow with friction and heat addition or loss. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321.

ME 420. Intermediate Heat Transfer. 3 or 4 hours.
Topics in conduction, convection and radiation with emphasis on exact solutions: extended surfaces, internal and external flows, surface radiation, combined modes of heat transfer and selected topics. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321 or consent of the instructor.

ME 421. Heat Exchangers. 3 or 4 hours.
Fundamentals: lost available work. Entropy generation minimization, optimal thermal design of: heat transfer augmentation devices, thermal energy storage, cryogenics, heat exchangers, thermal insulations, solar collectors. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321.

ME 422. Heat Exchangers. 3 or 4 hours.
Introduction to numerical solution methods for problems in mechanical engineering. Example problems include heat transfer, fluid mechanics, thermodynamics, mechanical vibrations, dynamics, stress analysis, and other related problems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321 or consent of the instructor.

ME 423. Applied Combustion. 3 or 4 hours.
Applications: solar geometry and intensities; solar heat transfer in buildings, heating and cooling loads, air-conditioning computer project. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321.

ME 424. Energy Management Solutions for Industry: Theory and Practice. 3 or 4 hours.
Emphasis on real world applications including: understanding utility billing and identifying costs; identifying and quantifying energy savings opportunities at industrial facilities; determining investment payback scenarios and considerations. Course Information: 3 undergraduate hours. 4 graduate hours. Extensive computer use required. Field work required. Extensive use of Microsoft Excel. Prerequisite(s): Junior standing or above.

ME 425. Second Law Analysis in Energy Engineering. 3 or 4 hours.
Prerequisites: Junior standing or above. Extensive use of Microsoft Excel. Prerequisite(s): ME 321.

ME 426. Applied Combustion. 3 or 4 hours.
Topics in combustion, providing both a theoretical and applied understanding of combustion processes as they relate to furnaces. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 326.

ME 427. Solar Engineering. 3 or 4 hours.
Introduction to numerical solution methods for problems in mechanical engineering. Example problems include heat transfer, fluid mechanics, thermodynamics, mechanical vibrations, dynamics, stress analysis, and other related problems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321 or consent of the instructor.

ME 428. Numerical Methods in Mechanical Engineering. 3 or 4 hours.
Introduction to numerical solution methods for problems in mechanical engineering. Example problems include heat transfer, fluid mechanics, thermodynamics, mechanical vibrations, dynamics, stress analysis, and other related problems. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321 or consent of the instructor.

ME 429. Internal Combustion Engines. 3 or 4 hours.
Introduction to engine types, characteristics and performance. Combustion processes in spark and compression ignition engines; combustion abnormalities. Analysis of intake, exhaust and fuel system. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 325.

ME 430. Non-Equilibrium Thermal Processes. 3 or 4 hours.
Molecular engineering. Non-equilibrium statistical mechanics. Distribution functions. Molecular excitation and de-excitation. Ionization and dissociation. Laser engineering. Non-equilibrium chemical kinetics. Surface processes. Chemisorption and physisorption. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 325 or consent of the instructor.
ME 441. Optical Methods in Mechanical Engineering. 0-4 hours.
Optical measurement techniques in solid mechanics and thermal-fluid engineering. Fundamentals of optics. Use of holography, interferometry, LDV, lasers, light scattering, diffraction, and other relevant techniques. Course Information: 3 undergraduate hours. 4 graduate hours. Prerequisite(s): Senior standing or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ME 444. Interdisciplinary Product Development I. 3 or 4 hours.
Cross-functional teams (w/students from AD 420/423 and MKTG 594) research and develop new product concepts. Focus on the identification of technologically appropriate product design problems. Course Information: Same as IE 444. 3 undergraduate hours. 4 graduate hours. Year-long (with IE/ME 445) project course. Prerequisite(s): Senior standing or above; and consent of the instructor.

ME 445. Interdisciplinary Product Development 2. 4 hours.
Cross-functional teams (w/students from AD 420 and MKTG 594) research and develop new product concepts. Focus on solutions to the opportunities identified in IE/ME 444 to functional prototypes. Serves as a replacement for IE/ME 396. Course Information: Same as IE 445. Year-long (with IE/ME 444) project course. Prerequisite(s): IE 444 or ME 444; and senior standing or above; and consent of the instructor.

ME 449. Microdevices and Micromachining Technology. 0-5 hours.
Microfabrication techniques for microsensors, microstructures, and microdevices. Selected examples of physical/chemical sensors and actuators. Simulation experiments. Course Information: Same as ECE 449. 4 undergraduate hours. 5 graduate hours. Laboratory. Prerequisite(s): ECE 347; or consent of the instructor. Class Schedule Information: To be properly registered, students must enroll in one Laboratory and one Lecture-Discussion.

ME 450. Air Pollution Engineering. 3 or 4 hours.
Environmental aspects of combustion processes, pollutant formation. Control of pollutants and particulates. Air quality control. Fundamentals of combustion. Course Information: Same as CHE 450. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): ME 321 or consent of the instructor.

ME 464. Virtual Automation. 0-4 hours.
Fundamentals of manufacturing and automation modeling using CAD/CAM and computer-integrated manufacturing methods; concepts of virtual manufacturing; industrial robots and automated factory models within virtual environments. Course Information: Same as IE 464. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 107 or CS 108. Class Schedule Information: To be properly registered, students must enroll in one Lecture-Discussion, and one Laboratory.

ME 468. Virtual Manufacturing. 3 or 4 hours.
Virtual reality applications in manufacturing systems design, manufacturing applications of networked virtual reality, virtual reality modeling of occupational safety engineering. Course Information: Same as IE 468. 3 undergraduate hours. 4 graduate hours. Prerequisite(s): CS 107 or CS 108.

ME 481. Additive Manufacturing Process. 3 or 4 hours.
Covers aspects of additive manufacturing. The types that are covered are generic process, design, vat photopolymerization, extrusion based, jetting, direct writing, 3D bio-printing, powder bed fusion, slicing, and data representation. Course Information: Same as IE 481. 3 undergraduate hours. 4 graduate hours. Recommended background: Manufacturing Processes.